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(54) Method for Extending an Edging Section onto a Work Piece and the Products Produced Thereby

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METHOD FOR EXTRUDING AN EDGING SECTION ONTO A WORK PIECE AND THE PRODUCTS PRODUCED THEREBY

The invention relates to a method for the manufacture of a work piece having an extruded plastic edging section running along one or more of its edges, to a work piece manufactured by said method, and to a heat exchanger in particular.

The bonding, for instance with an adhesive, of a separate extruded section of thermoplastic resin onto the edge of a body like a sheet of pressboard or plastic having a cross-section that is uniform along its edge is generally known. The adhesive is usually applied by hand. The separately manufactured edging section is also usually cut into lengths and applied by hand.

There are in many cases disadvantages to the use of adhesives because solvents can seep into the plastic edging section and, if the edging section is to be applied to a plastic body, into the latter as well, which can cause stress corrosion. The strength of adhesive seams also often leaves much to be desired.

The present invention provides a method of manufacturing work pieces having attached edging sections, for example plastic heat exchangers, and especially a method that avoids steps in the operation that must be carried out by hand. This method also permits the formation of a strong bond between the work piece and the edging section

without the use of an adhesive. Such method comprises applying a molten strip of thermoplastic resin, having the cross-section of the edging section to be produced, to the edge region of the work piece by inserting the edge region of the work piece into a suitable forming die. The forming die has a molding channel for receiving the edge region and sealing edge portions adjacent the channel in contact with the edge region at a selected distance from the edge of the work piece. The strip of thermoplastic resin is supplied to the channel. Relative movement between the forming die and the edge region of the work piece is arranged to occur at the rate at which the molten thermoplastic resin emerges from the forming die to form the edging section.

If the work piece is made of a thermoplastic resin, it is suitable for the edging section to be made of the same or of a similar plastic. The plastics can be considered similar if the edging section, while in a thermoplastic state, can be welded to the edge of the body to form a single piece and if the resulting bond is permanent.

A core rod may be positioned in the molding channel of the die parallel to the exit direction of the edging section thereby to produce a cavity running through the edging section.

The invention further comprises a work piece having an extruded edging section, manufactured by the process according to the invention. Such work piece may comprise a plastic heat exchanger including a plastic body in the form of a panel having two parallel, flat outer walls. A number of webs extending between the walls and connecting the walls to define a plurality of parallel flowthrough channels. A pair of plastic collector elements cooperate to define a conduit in the edge section. This conduit is connected to the body of the heat exchanger in communication with the flowthrough channels.

A better understanding of the present invention and of its many advantages will be had by referring to the accompanying drawings, in which

Fig. 1 is a perspective view of a planar work piece having an edging section along an edge thereof;

Fig. 1A is a side view, in section, through an extrusion die employed to produce the edging section showing a work piece inserted into the die;

Fig. 2 is a similar side view, in section, of an extrusion die suited for the production of an edging section having a cavity running through it;

Fig. 3 is a plan view, in section along line 3-3 of Fig. 2 of the apparatus shown in Fig. 2;

Fig. 4 is an exploded side view, in section, of a heat exchanger according to the present invention, said exchanger comprising a body containing flow-through channels and collector conduits in communication therewith;

Fig. 4A is a side view, in section, of the same heat exchanger after assembly and attachment thereto of an edging section;

Fig. 5 is an exploded side view, in section, of a further embodiment of a heat exchanger according to the present invention again comprising a body having flowthrough channels and collector conduits in communication therewith;

Fig. 5A is a side view of the heat exchanger of Fig. 5 after assembly and attachment thereto of an edging section; and

Fig. 6 is a plan view, in section, of part of the heat exchanger shown in Fig. 4.

Referring in particular to Fig. 1 of the drawings, work piece or panel 11 that is to be provided in accordance with the invention with edging section 12 running along an edge thereof may consist of any desired solid material that is dimensionally stable under the conditions under which the edging section is extruded. Suitable materials are such metals as aluminum, iron, or copper, plastics like polymethyl methacrylate, polycarbonate, polyvinyl chloride, polystyrene, polyolefins,phenolic resins or aminoplast resins, materials like wood, chipboard, cardboard, laminates, and even foam if its resistance to pressure and heat is high enough. The work piece may be composed of several different materials or parts which may, indeed, first be firmly fastened together only after the edging section is applied.

It is assumed in any case that the work piece will have a uniform cross-section longitudinally along the edge to which the edging section is to be bonded. Rough places or small irregularities in the edge region to be covered by the edging section are not significant so long as the surface of the

work piece immediately adjacent to the edging section is uniform. The most desirable type of work piece is a plate or sheet with plane parallel surfaces and at least one straight edge.

The work piece may contain one or more cavities therein. Its outer walls must be sufficiently resistant to temperature and pressure not to be damaged by the hot molding material under pressure.

The "edge region" of the work piece in the sense of the present invention is one of its outer, bounding edges together with the adjacent surface areas; in plate-type pieces these are the top and bottom surface areas. The extent of an edge region that is to be provided with an edging section can differ from case to case, from a few millimeters to several centimeters for example. As a rule, the edging section will cover the edge and the adjacent top and bottom edge regions to about 5 mm to 50 mm from the edge. In the extreme case, the area covered by the edging section may be larger than the area left uncovered on the work piece. As the edging section is being manufactured, the edge region to be covered will be bounded by the sealing lips of the forming tool or die, which lips will be in contact with the edge region at a distance from the outside edge.

An extrudable molding material, such as polymethyl methacrylate, polystyrene, polycarbonate, polyvinyl chloride, or polyolefins,is appropriate for manufacture of the edging section. These materials may be dyed or pigmented in the

usual way. If the edging section is to serve as a sealing strip, soft-elastic plastics such as soft polyvinyl chloride or high-pressure polyethylene are preferred.

Referring now to Fig. 1A, the figure shows forming tool or die 13 according to the invention. Its design resembles that of known tools for sheathing cable or the like with an extruded plastic layer. But whereas the cross-section of the molding channel in a sheathing tool is a closed curve, molding channel 14 of the present invention is shaped like a horseshoe, with edge region 15 of work piece 11 to be provided with edging section 12 extending into channel 14 at the open side thereof. Die 13 comprises two jaws 16, 17 joined at the base to enclose laterally open intake channel 18 in communication in the direction of extrusion with molding channel 14, also laterally open. Jaws 16, 17 close securely over the surface of the body piece and terminate in sealing lips 19, 20 in the vicinity of molding channel 14. Sealing lips 19, 20 are separated by a distance equal to the thickness of edge region 15 of work piece 11 and are in close contact with said region when the machine is in operation.* Inside the cross-section bounded by the lips, molding channel 14 is separated from the inserted edge region 15 of work piece 11 by a distance equal to the thickness of edging section 12.

Edging section 12 can be of many different shapes. It may completely enclose edge region 15 or be limited to edge 21 or to one or more areas inside the adjacent edge region.

* A direct contact of the sealing lips with the body piece is not necessary. Rather, if there is a gap between the lips and the surface of the body piece or the said surface is not quite uniform in cross section the sealing lips should close only tightly enough to prevent considerable leakage of liquid molding material.

It may also consist of several separate strips. Its thickness may be uniform or be different at different locations along its length, ranging, for example, from 0.5 mm to 10 mm.

As is more particularly shown in Figs. 2 and 3, an edging section having one or more cavities therein can be produced using a die 13 provided with at least one core rod 23. Rod 23 may be in contact with edge 21 of work piece 11, as shown in Figs. 2 and 3, or may be completely surrounded by molding material 24. In practice, a core rod mounted in a fixed position in the tool can cause problems. These can be avoided by positioning a freely moving rod against the edge of a work piece, feeding the rod into the tool together with the edge region of the work piece, and removing the rod after the edging section is formed.

In carrying out the method according to the present invention, edge region 15 of work piece 11 is introduced into work piece feed channel 25 and is transported toward molding channel 14. As the work piece enters the molding channel, edging section 12 is applied. The feed rate of work piece 11 is adjusted to the rate at which edging section 12 can be applied. The production rate can be controlled in a known way by means of the output of the extruder (not shown in the drawings), with thermoplastic molding material 24 being supplied from the extruder through intake channel 18 into molding channel 14.

As a rule, an immovably mounted tool or die connected to an immovably mounted extruder is employed. The edge region

of the work piece in such a case is conveyed in an appropriate feed direction into the feed channel and hence into the molding channel. In continuous operation it is practical to convey the work pieces to be provided with edging sections in an uninterrupted sequence through the tool. This produces a continuous edging section that can be cut up at appropriate points between the individual work pieces as it emerges from the tool. The feed system may be equipped with stop 26 (cf. Fig. 1A) to prevent body piece 11 from being forced out of tool 13 by the pressure of the molding material. Such a stop 26 can be omitted if two edging sections are produced at the same time on parallel and opposite edges of one work piece.

If the work piece to be provided with an edging section is large, unwieldy, or immovable, it may be simpler to employ a movable tool that can be moved along the edge region of the stationary piece.

The edging sections produced in accordance with the invention may serve different purposes, for example as an edge protector for fragile pieces, or to form a smooth edge on a piece with irregular or rough edges, or as a frame for various types of installation or mounting systems, or as an elastic seal.

Figs. 4-6 refer to a preferred embodiment of the invention pertinent to the manufacture of a plastic heat exchanger 30 consisting of an extruded plastic body in the form of a plate having two parallel, flat outer walls 31

connected by a large number of webs 32 to form a large number of parallel flowthrough channels 33 running between outer walls 31 and webs 32 to edges 34 of the body of the heat exchanger, and of two plastic collectors 35 each connected to an edge 34 of the body of the heat exchanger and in communication with flowthrough channels 33. Collector 35 can be prefabricated and provided with a large number of smaller, lateral connecting tubes 36. The prefabricated collectors are then attached to edge 34 of the heat-exchanger body in such a way that connecting tubes 36 project into throughflow channels 33 and, according to the present invention, are connected to the heat exchanger body by extruding thereover edging section 37 which extends over the collector onto the planar body of the heat exchanger. The collectors preferably consist of at least two separate longitudinal segments and of a layer that surrounds them and that grips the body of the heat exchanger.

Separate segments can be made by injection molding more simply and cheaply than a one-piece tube. Referring to Figs. 4 and 4A, collector segments 38, 39 are joined together before final assembly of the heat exchanger and are attached to edge 34 of heat exchanger 30 in a way such that the interior of collector 35 is in communication through tubes 36 with flowthrough channels 33. After the various parts have been so assembled, surrounding edging section 37 which holds collector segments 38, 39 together and at the same time constitutes the connection between collector 35 and the body of heat exchanger 30 is extruded over the assembled parts. Edging section 37 avoids the need for an adhesive connection

of segments 38, 39 to each other or to the body of the piece so that gluing or welding the individual parts together can be eliminated.

Extruded edging section 37 must be made thick enough to accept the pressure of the fluid flowing through collector 35 when the heat exchanger is in operation. It must be connected to the body of the exchanger firmly enough to ensure against separation of the collector.

The inner portions of collector 35 can be separated into segments along various planes parallel to its longitudinal axis. It is not necessary to divide it into more than two parts. In the embodiment shown in Figs. 4 and 4A, the plane of division runs parallel to edge 34 of the heat exchanger and passes through the axis of the collector. Segment 39 immediately adjacent to edge 34 is provided with openings 40 into flowthrough channels 33. These openings can be formed in lateral connecting tubes 36.

In the embodiment in Figs. 5 and 5A, the plane dividing collector 35 into segments 38', 39' is in the median plane of the body of heat exchanger 30. Lateral connecting tubes 36' are also made in two parts in this embodiment. Tubes 36' serves as supports which project into flowthrough channels 33 and not only serve temporarily to fasten segments 38', 39' to the heat exchanger but also to reinforce edge 34 in the region where edging section 37 is fastened to the exterior. While this edging section is being extruded, the molding material exerts considerable pressure in the region of edge 34. The

body of the heat exchanger is usually not large enough to resist this pressure by itself. Tubular supports 36 and 36' must be designed thick enough so that their total cross-section does not get warmer than the glass transition temperature while edging section 37 is being extruded and so that they can support the body of the heat exchanger against the pressure of the molding material.

According to a preferred embodiment of the invention shown in Fig. 6, one end of collector 35 comprises two plugs 41, 42 without openings. When extruded edging section 37 is formed, the molding material forces itself between them and forms a tight bond with the collector at the outer edge region of the heat-exchanger plate as well.

In another preferred embodiment, collector 35 projects on at least one end thereof beyond side 43 of the heat exchanger. Projecting portion 44 serves as a support and connection for intake or release of the heat-exchanger fluid.

Especially suitable materials for the manufacture of the heat exchanger are the polyolefins, and polypropylene in particular. These plastics may be dyed or pigmented. If use as a solar collector is contemplated, a plastic with a heat-absorbent color should be employed. Carbon black is especially effective.

Heat exchangers in accordance with the invention may have gaseous or liquid heat-exchange media flowing through them that are inert with respect to the particular plastic employed. The operating temperature of the heat exchanger must be lower than the softening temperature of the plastic. In operation,

the heat exchanger may be surrounded by another liquid or gaseous heat-absorbing or heat-emitting medium, or the heat exchange may occur with incident heat rays, especially sunlight.

The ratio of the thickness of the walls of the collector to its largest inside dimension is preferably no more than twice the ratio of the outer walls of the body of the heat exchanger to its inside dimension. These ratios are determined only by specified strength requirements and by the pressure of the heat-exchange medium flowing through the collector.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. The method of forming an extruded edging section of a thermoplastic resin on the edge of a work piece having a substantially uniform edge cross-section, said method comprising the steps of applying a molten strip of thermoplastic resin, having the cross-section of the edging section to be produced, to the edge region of the work piece by inserting said edge region of the work piece into a forming die having a molding channel receiving said edge region and sealing edge portions adjacent the channel in contact with said edge region at a distance from the edge of the work piece, supplying said thermoplastic resin to said channel, and causing relative movement between the forming die and the edge region of the work piece at the rate at which said molten thermoplastic resin emerges from the forming die to form said edging section.

2. The method as in Claim 1 wherein said work piece is formed of a similar type of plastic as said edging section.

3. The method as in Claim 1 including the step of positioning a core rod in the molding channel of the die parallel to the exit direction of the edging section thereby to produce a cavity running through the edging section.

4. The method as in Claim 1 wherein said edging section of the work piece is composed of a plurality of elements forming a conduit in said edging section and said method includes securing said elements together by the formation of said edging section.

5. A work piece having an extruded edging section, manufactured by a process as defined in Claim 4.

6. A work piece as in Claim 5, comprising a plastic heat exchanger including a plastic body in the form of a panel having two parallel, flat outer walls and a plurality of webs extending therebetween and connecting said walls to define a plurality of parallel flowthrough channels, and a pair of plastic collector elements cooperating to define a conduit in said edge section and connected to the body of the heat exchanger in communication with said flowthrough channels.

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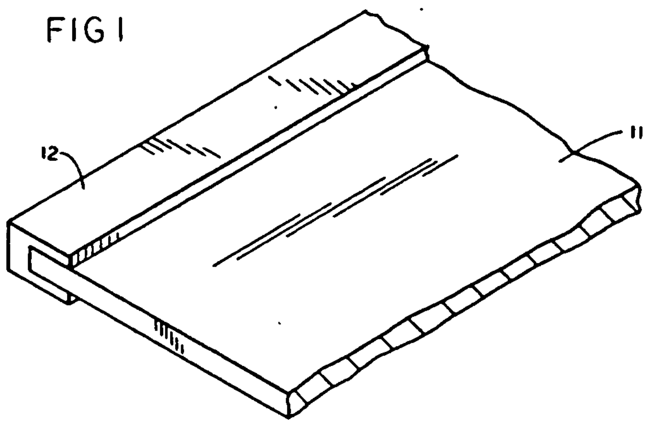
FIG I



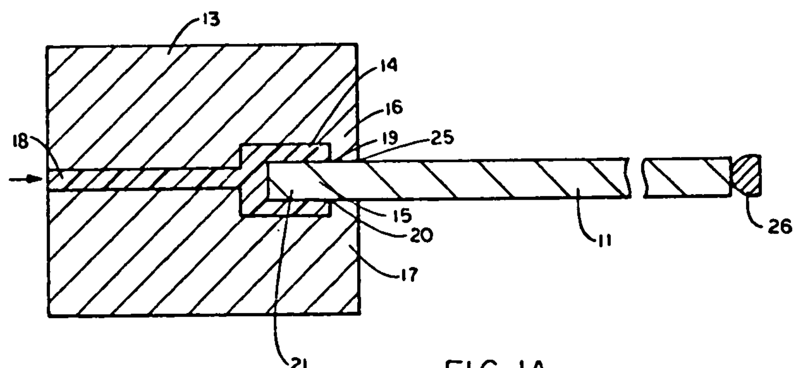




FIG IA

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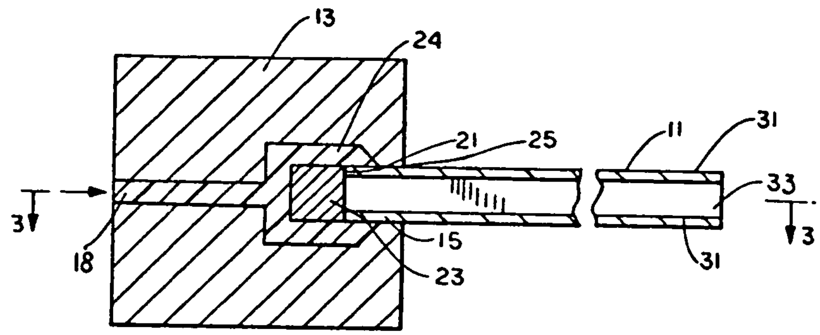


FIG 2

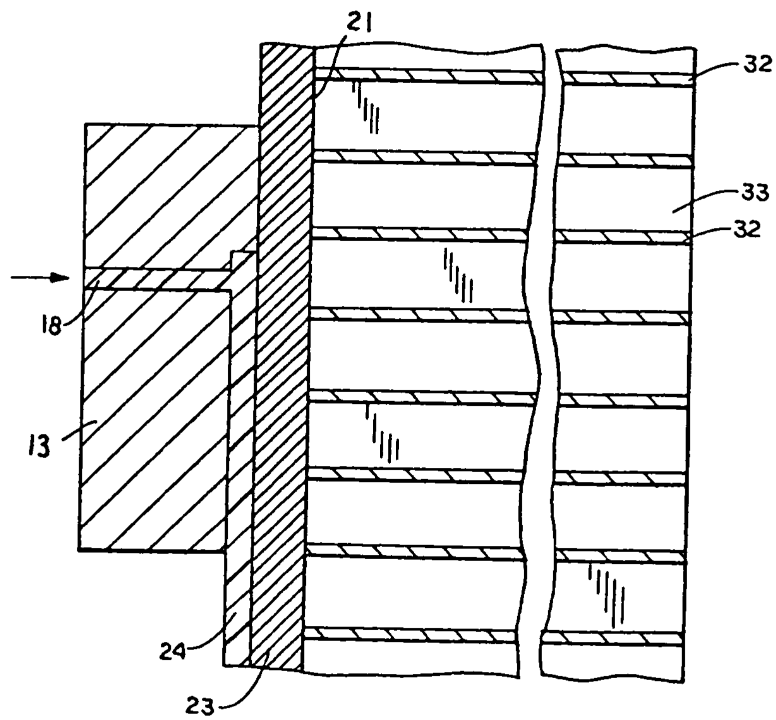


FIG 3

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FIG 4

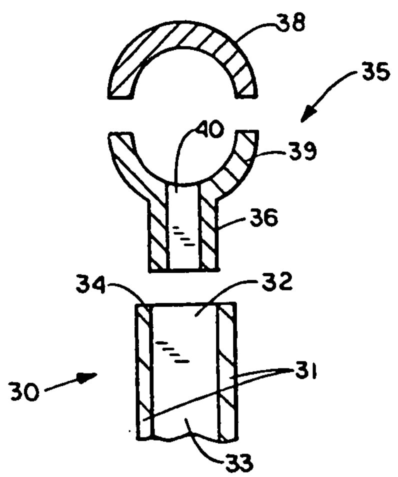
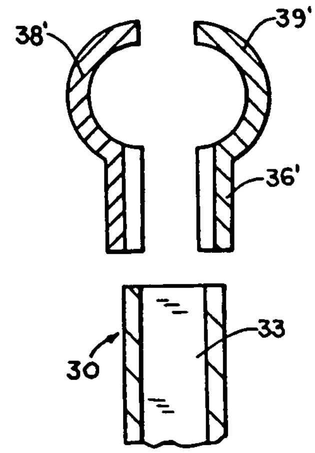



FIG 5



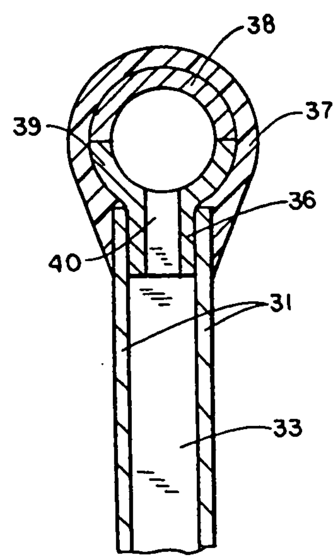




FIG 4A

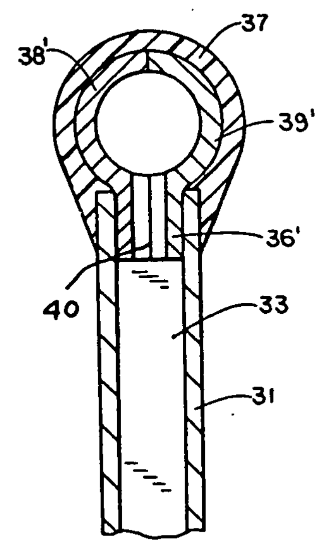



FIG 5A

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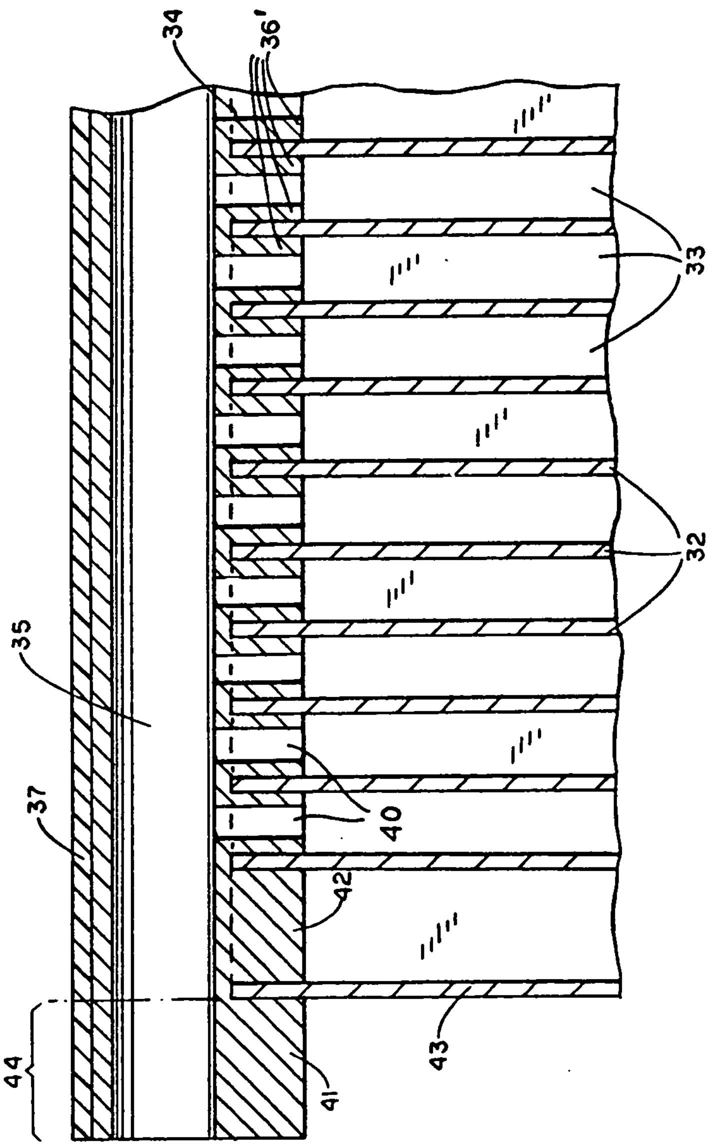


FIG 6

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